



## Apparatus for Sensing Fluid Flow in a Pipe

### BACKGROUND OF THE INVENTION

#### 1. Technical Field

5           This invention relates to fluid flow sensing devices that use fiber optics and more particularly to those devices that measure the speed of sound, flow velocity, and other parameters within a pipe using acoustic signals, and local short duration pressure variations within the flow.

#### 2. Background Information

10           In the petroleum industry, there is considerable value in the ability to monitor the flow of petroleum products in the production pipe of a well in real time. Historically, flow parameters such as the bulk velocity of a fluid have been sensed with venturi type devices directly disposed within the fluid flow. These type devices have several drawbacks including the fact that they provide an  
15           undesirable flow impediment, are subject to the hostile environment within the pipe, and typically provide undesirable potential leak paths into or out of the pipe. In addition, these type devices are also only able to provide information relating to the bulk fluid flow and are therefore unable to provide information specific to constituents within a multi-phase flow.

20           Some techniques utilize the speed of sound to determine various parameters of the fluid flow within a pipe. One technique measures the amount of time it takes for sound signals to travel back and forth between ultrasonic acoustic transmitters/receivers (transceivers). This is sometimes referred to a "sing-around" or "transit time" method. United States Patent numbers 4,080,837,  
25           4,114,439, 5,115,670 disclose variations of this method. A disadvantage of this type of technique is that gas bubbles and/or particulates in the fluid flow can interfere with the signals traveling back and forth between the transceivers. Another disadvantage of this type of technique is that it considers only the fluid disposed between transceivers during the signal transit time. Fluid flow within a  
30           well will very often be non-homogeneous, for example containing localized concentration variations ("slugs") of water or oil. Localized concentration variations can affect the accuracy of the data collected.